FIGURE 1

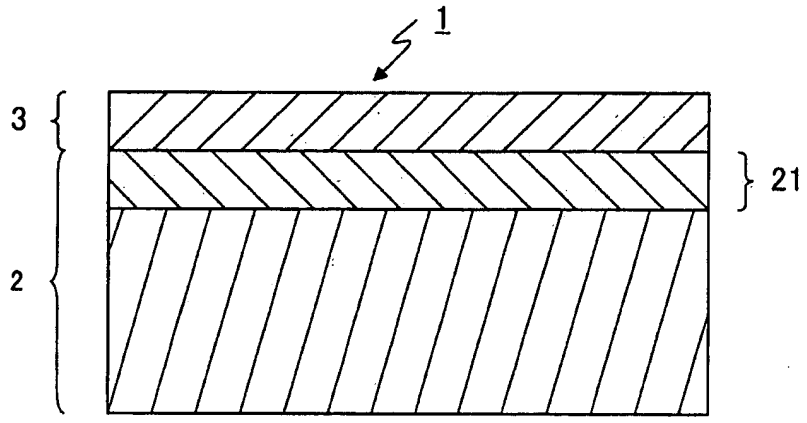

FIGURE 2

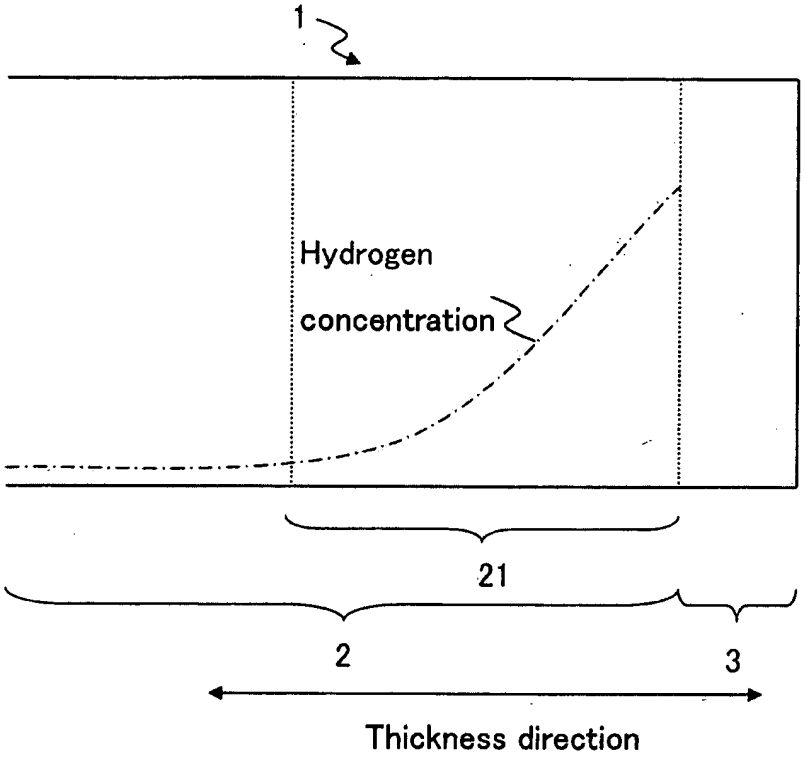

FIGURE 3

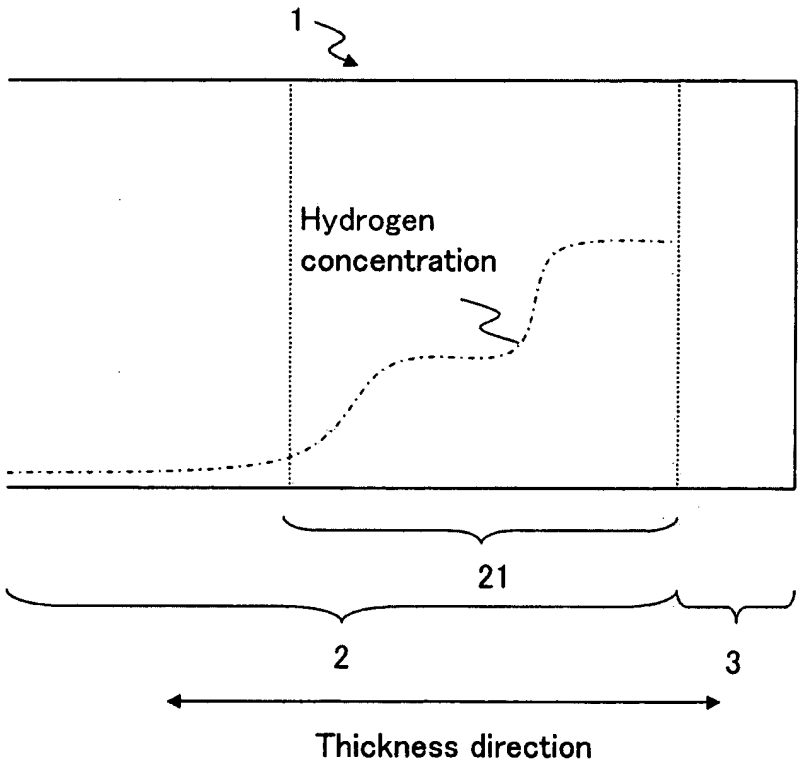

FIGURE 4

	Nd (wt%)	Pr (wt%)	Dy (wt%)	Tb (wt%)	B (wt%)	Al (wt%)	Co (wt%)	Cu (wt%)	Zr (wt%)	Nb (wt%)	N (ppm)	O (ppm)	C (ppm)	Fe
Composition A	24.5	5.5	—	—	1.0	0.2	0.5	0.05	—	—	330	1520	290	bal.
Composition B	25.0	5.5	—	—	1.0	0.2	0.5	0.05	0.15	—	400	1010	200	bal.
Composition C	20.0	5.5	5.0	—	1.0	0.25	0.5	0.10	—	—	420	1800	490	bal.
Composition D	22.0	—	7.5	—	1.0	0.25	0.5	0.07	—	0.7	310	1640	710	bal.
Composition E	24.5	5.5	-	—	1.0	0.2	0.5	0.05	0.05	—	410	1220	310	bal.
Composition F	24.5	5.5	-	—	1.0	0.2	0.5	0.05	0.30	—	480	1150	350	bal.
Composition G	20.0	5.5	5.0	—	1.0	0.2	0.5	0.05	—	0.2	440	1430	320	bal.
Composition H	20.0	5.5	5.0	—	1.0	0.2	0.5	0.05	—	1.5	350	1090	290	bal.
Composition I	20.0	5.5	5.0	—	1.0	0.2	0.5	0.05	—	2.3	390	1310	380	bal.
Composition J	28.5	—	1.0	1.0	1.0	0.25	0.5	0.10	—	—	390	810	350	bal.

FIGURE 5

Sample No.	Alloy composition	Evaluation of corrosion resistance		Magnetic properties			$R_2Fe_{14}B$ grain	
		Thickness of hydrogen-rich layer [μm]	Corrosion resistance	Br [T]	HcJ [kA/m]	Hk/Hc j [%]	10 μm or less [%]	20 μm or more [%]
1	Composition A	0	5/100	1.473	907	96.0	92	1
2		20	0/100					
3		40	0/100					
4		100	1/100					
5		160	2/100					
6		200	2/100					
7		250	4/100					
8		300	5/100					
9	Composition B	45	0/100	1.460	945	97.5	97	0
10	Composition C	20	0/100	1.431	2020	96.2	93	1
11	Composition D	22	0/100	1.220	2325	98.3	95	0
12	Composition E	40	0/100	1.475	879	94.9	94	1
13	Composition F	20	0/100	1.461	922	92.8	97	0
14	Composition G	20	0/100	1.324	2040	96.7	94	0
15	Composition H	20	0/100	1.297	2115	97.3	96	0
16	Composition I	20	0/100	1.259	2190	97.3	98	0
17	Composition J	50	0/100	1.424	1405	98.1	94	0

FIGURE 6

Sample No.	Nd (wt%)	B (wt%)	Al (wt%)	Co (wt%)	Cu (wt%)	Zr (wt%)	N (ppm)	O (ppm)	C (ppm)	Fe
18	30.5	1.0	0.2	0.5	0.1	0.2	890	1200	640	bal.
19							100	850	850	bal.
20							1800	950	650	bal.
21							530	3000	850	bal.
22							650	780	1800	bal.
23	32.8						780	890	870	bal.

FIGURE 7

Sample No.	Evaluation of corrosion resistance		Magnetic properties			$R_2Fe_{14}B$ grain	
	Thickness of hydrogen-rich layer [μm]	Corrosion resistance	Br [T]	HcJ [kA/m]	Hk/Hc j [%]	10 μm or less [%]	20 μm or more [%]
18	50	0/100	1.451	925	97.6	96	0
19	50	6/100	1.450	954	97.4	95	0
20	50	0/100	1.443	868	92.0	92	0
21	50	0/100	1.432	825	91.1	93	0
22	50	0/100	1.443	903	96.7	94	0
23	50	9/100	1.349	1085	96.2	92	0

FIGURE 8

Chemical composition							Magnetic properties		
Nd (wt%)	Pr (wt%)	B (wt%)	Al (wt%)	Co (wt%)	Cu (wt%)	Fe	Br [T]	HcJ [kA/m]	Hk/Hc j [%]
24.5	5.5	1.0	0.2	0.5	0.05	bal.	1.473	907	96

FIGURE 9

Sample No.	Etching conditions	Plating conditions
24	10% Nitric acid solution (40° C), 3 min.	Bath temp.: 55° C, 0.3 A/dm^2, 300 min.
25	5% Nitric acid solution (40° C), 8 min.	Bath temp.: 40° C, 2.0 A/dm^2, 50 min.
26	5% Nitric acid solution (40° C), 10 min.	Bath temp.: 50° C, 0.15 A/dm^2, 700 min.
27	5% Nitric acid solution (40° C), 10 min.	Bath temp.: 60° C, 4.5 A/dm^2, 20 min.
28	5% Nitric acid solution (40° C), 10 min.	Bath temp.: 40° C, 2.5 A/dm^2, 40 min.

FIGURE 10

Sample No.	Before barrel polishing treatment			After barrel polishing treatment			After acid etching			After plating treatment		
	Dimension A	Dimension B	Dimension C	Dimension A	Dimension B	Dimension C	Dimension A	Dimension B	Dimension C	Dimension A	Dimension B	Dimension C
24	0.004880	0.004737	0.003516	0.006165	0.004652	0.002759	0.005005	0.004105	0.002385	0.008062	0.005532	0.003904
25	0.003848	0.004478	0.003689	0.004936	0.004713	0.004051	0.004742	0.005138	0.003583	0.007836	0.006102	0.003437
26	0.004969	0.005277	0.003562	0.005389	0.004969	0.003138	0.008126	0.007778	0.007057	0.011073	0.009396	0.011250
27	0.004432	0.005845	0.004190	0.005528	0.004899	0.005445	0.006949	0.007273	0.007226	0.010519	0.009038	0.009860
28	0.004584	0.004477	0.004779	0.004919	0.006856	0.007772	0.005974	0.007798	0.008698	0.010909	0.009185	0.010268

FIGURE 11

Dimension A (mm)				
	Before barrel polishing treatment	After barrel polishing treatment	After acid etching treatment	After plating treatment
1	6.002	5.993	5.971	6.005
2	5.991	5.977	5.964	5.983
3	5.990	5.975	5.981	6.004
4	6.005	5.992	5.972	5.986
5	5.995	5.982	5.974	6.006
6	6.003	5.989	5.977	5.991
7	5.997	5.986	5.965	6.003
8	5.999	5.987	5.970	5.994
9	5.994	5.994	5.976	5.989
10	6.001	5.988	5.975	5.999
Average	5.998	5.986	5.973	5.996

Dimension B (mm)				
	Before barrel polishing treatment	After barrel polishing treatment	After acid etching treatment	After plating treatment
1	3.999	3.996	3.967	4.001
2	4.006	3.984	3.978	3.989
3	4.003	3.983	3.969	3.991
4	3.995	3.987	3.979	4.003
5	3.990	3.981	3.974	3.994
6	4.000	3.991	3.967	3.997
7	4.001	3.984	3.969	3.997
8	3.994	3.982	3.969	4.001
9	4.002	3.986	3.973	3.992
10	4.004	3.992	3.970	3.985
Average	3.999	3.987	3.972	3.995

Dimension C (mm)				
	Before barrel polishing treatment	After barrel polishing treatment	After acid etching treatment	After plating treatment
1	0.804	0.790	0.774	0.791
2	0.801	0.788	0.768	0.800
3	0.799	0.787	0.766	0.789
4	0.800	0.788	0.768	0.789
5	0.791	0.791	0.772	0.791
6	0.798	0.788	0.771	0.789
7	0.794	0.793	0.773	0.798
8	0.796	0.782	0.769	0.796
9	0.796	0.789	0.771	0.792
10	0.799	0.787	0.769	0.789
Average	0.798	0.788	0.770	0.792

FIGURE 12

Dimension A (mm)				
	Before barrel polishing treatment	After barrel polishing treatment	After acid etching treatment	After plating treatment
1	5.998	5.984	5.974	5.992
2	6.002	5.992	5.980	6.003
3	5.993	5.977	5.977	5.994
4	5.999	5.990	5.978	5.981
5	6.003	5.989	5.983	5.992
6	5.998	5.979	5.978	6.002
7	5.994	5.989	5.969	5.996
8	5.997	5.984	5.981	6.004
9	5.991	5.992	5.969	5.982
10	6.002	5.986	5.982	6.001
Average	5.998	5.986	5.977	5.995

Dimension B (mm)				
	Before barrel polishing treatment	After barrel polishing treatment	After acid etching treatment	After plating treatment
1	4.004	3.994	3.977	4.005
2	3.998	3.988	3.984	4.002
3	4.003	3.979	3.975	3.989
4	3.994	3.990	3.984	4.002
5	3.999	3.984	3.969	3.992
6	3.992	3.988	3.974	3.990
7	4.004	3.981	3.976	4.000
8	4.002	3.989	3.969	3.988
9	3.992	3.986	3.972	4.002
10	3.997	3.994	3.980	3.994
Average	3.999	3.987	3.976	3.996

Dimension C (mm)				
	Before barrel polishing treatment	After barrel polishing treatment	After acid etching treatment	After plating treatment
1	0.802	0.784	0.769	0.792
2	0.799	0.788	0.776	0.796
3	0.801	0.790	0.768	0.791
4	0.802	0.783	0.772	0.798
5	0.790	0.788	0.766	0.794
6	0.795	0.781	0.765	0.799
7	0.797	0.795	0.774	0.794
8	0.799	0.789	0.775	0.792
9	0.802	0.782	0.769	0.789
10	0.796	0.787	0.772	0.788
Average	0.798	0.787	0.771	0.793

FIGURE 13

Dimension A (mm)				
	Before barrel polishing treatment	After barrel polishing treatment	After acid etching treatment	After plating treatment
1	5.997	5.979	5.969	6.001
2	6.004	5.982	5.982	5.990
3	5.989	5.993	5.962	6.003
4	5.998	5.989	5.977	5.989
5	5.997	5.976	5.973	5.977
6	6.004	5.986	5.979	6.008
7	5.991	5.990	5.965	6.003
8	5.995	5.992	5.961	5.982
9	6.003	5.987	5.958	5.979
10	6.001	5.990	5.978	6.005
Average	5.998	5.986	5.970	5.994

Dimension B (mm)				
	Before barrel polishing treatment	After barrel polishing treatment	After acid etching treatment	After plating treatment
1	3.994	3.991	3.958	3.998
2	4.004	3.977	3.977	4.008
3	3.991	3.982	3.976	3.989
4	4.003	3.989	3.972	4.006
5	3.996	3.989	3.968	3.992
6	4.000	3.992	3.965	4.002
7	3.994	3.985	3.978	3.991
8	3.989	3.983	3.959	3.988
9	4.005	3.981	3.981	4.007
10	3.999	3.992	3.977	3.978
Average	3.998	3.986	3.971	3.996

Dimension C (mm)				
	Before barrel polishing treatment	After barrel polishing treatment	After acid etching treatment	After plating treatment
1	0.801	0.784	0.762	0.792
2	0.795	0.788	0.777	0.803
3	0.803	0.779	0.754	0.782
4	0.797	0.788	0.769	0.776
5	0.799	0.791	0.773	0.780
6	0.801	0.788	0.771	0.804
7	0.790	0.786	0.773	0.779
8	0.800	0.785	0.758	0.802
9	0.796	0.789	0.771	0.798
10	0.799	0.787	0.772	0.806
Average	0.798	0.787	0.768	0.792

FIGURE 14

Dimension A (mm)				
	Before barrel polishing treatment	After barrel polishing treatment	After acid etching treatment	After plating treatment
1	6.005	5.982	5.966	5.999
2	5.999	5.977	5.977	5.992
3	6.003	5.990	5.980	6.002
4	6.000	5.988	5.969	5.988
5	6.002	5.991	5.979	5.975
6	5.997	5.986	5.981	5.982
7	5.996	5.991	5.965	6.004
8	5.992	5.979	5.977	5.988
9	6.006	5.976	5.960	5.979
10	5.994	5.988	5.975	6.007
Average	5.999	5.985	5.973	5.992

Dimension B (mm)				
	Before barrel polishing treatment	After barrel polishing treatment	After acid etching treatment	After plating treatment
1	3.993	3.992	3.967	3.992
2	4.004	4.000	3.972	4.005
3	3.995	3.989	3.984	3.991
4	4.005	3.989	3.970	3.976
5	4.002	3.991	3.974	4.003
6	3.996	3.989	3.959	3.989
7	3.991	3.990	3.972	3.994
8	3.989	3.986	3.961	3.986
9	4.006	3.980	3.977	4.002
10	4.001	3.994	3.963	3.981
Average	3.998	3.990	3.970	3.992

Dimension C (mm)				
	Before barrel polishing treatment	After barrel polishing treatment	After acid etching treatment	After plating treatment
1	0.800	0.788	0.772	0.782
2	0.793	0.790	0.773	0.799
3	0.804	0.774	0.760	0.802
4	0.799	0.787	0.759	0.789
5	0.802	0.779	0.783	0.772
6	0.794	0.791	0.778	0.800
7	0.792	0.788	0.772	0.781
8	0.803	0.782	0.764	0.792
9	0.797	0.784	0.770	0.799
10	0.794	0.792	0.766	0.801
Average	0.798	0.786	0.770	0.792

FIGURE 15

Dimension A (mm)				
	Before barrel polishing treatment	After barrel polishing treatment	After acid etching treatment	After plating treatment
1	6.003	5.979	5.972	6.005
2	6.002	5.985	5.969	5.994
3	5.992	5.988	5.980	6.003
4	5.998	5.994	5.977	5.989
5	6.001	5.988	5.974	5.979
6	5.994	5.984	5.982	5.981
7	5.999	5.984	5.967	6.001
8	5.992	5.977	5.981	5.986
9	6.004	5.981	5.963	5.977
10	5.992	5.990	5.974	6.008
Average	5.998	5.985	5.974	5.992

Dimension B (mm)				
	Before barrel polishing treatment	After barrel polishing treatment	After acid etching treatment	After plating treatment
1	3.995	3.982	3.985	4.003
2	4.001	3.998	3.977	4.002
3	4.002	3.999	3.985	3.996
4	3.999	4.003	3.968	3.992
5	3.991	3.988	3.979	3.980
6	3.995	3.994	3.982	4.003
7	4.001	3.989	3.960	3.978
8	3.990	4.001	3.980	4.005
9	4.004	3.984	3.969	3.988
10	3.998	3.992	3.972	3.995
Average	3.998	3.993	3.976	3.994

Dimension C (mm)				
	Before barrel polishing treatment	After barrel polishing treatment	After acid etching treatment	After plating treatment
1	0.802	0.789	0.769	0.800
2	0.804	0.772	0.784	0.798
3	0.788	0.793	0.767	0.804
4	0.794	0.792	0.780	0.791
5	0.798	0.775	0.763	0.767
6	0.795	0.792	0.783	0.794
7	0.792	0.789	0.759	0.796
8	0.799	0.777	0.782	0.798
9	0.801	0.794	0.781	0.802
10	0.793	0.784	0.777	0.804
Average	0.797	0.786	0.775	0.795

FIGURE 16

	Nd (wt%)	Pr (wt%)	Dy (wt%)	Tb (wt%)	B (wt%)	Al (wt%)	Co (wt%)	Cu (wt%)	Zr (wt%)	Nb (wt%)	Fe
Composition A	24.5	5.5	—	—	1.0	0.2	0.5	0.05	—	—	bal.
Composition B	25.0	5.5	—	—	1.0	0.2	0.5	0.05	0.15	—	bal.
Composition C	20.0	5.5	5.0	—	1.0	0.25	0.5	0.10	—	—	bal.
Composition D	22.0	—	7.5	—	1.0	0.25	0.5	0.07	—	0.7	bal.
Composition E	24.5	5.5	-	—	1.0	0.2	0.5	0.05	0.05	—	bal.
Composition F	24.5	5.5	-	—	1.0	0.2	0.5	0.05	0.30	—	bal.
Composition G	20.0	5.5	5.0	—	1.0	0.2	0.5	0.05	—	0.2	bal.
Composition H	20.0	5.5	5.0	—	1.0	0.2	0.5	0.05	—	1.5	bal.
Composition I	20.0	5.5	5.0	—	1.0	0.2	0.5	0.05	—	2.3	bal.
Composition J	28.5	—	1.0	1.0	1.0	0.25	0.5	0.10	0.20	—	bal.
Composition K	30.5	—	—	—	1.0	0.2	0.5	0.10	0.20	—	bal.

FIGURE 17

Sample No.	Alloy composition	Plating	Hydrogen concentration profile	Thickness of hydrogen-rich layer (1000 ppm or more in hydrogen) [μm]	Hydrogen concentration at a position of 500 μm from surface [ppm]	Peeling off strength [N/m]			Corrosion resistance	Magnetic properties		
						Before thermal shock test	After thermal shock test	Rate of change [%]		Br [T]	HcJ [kA/m]	Hk/Hcj [%]
29	Composition A	Electrolytic Ni	Uniform	0	25	83	80	−3.6	5/100	1.473	907	96.0
30			Decreasing continuously	20	20	125	122	−2.4	0/100			
31				40	10	124	126	1.6	0/100			
32				100	15	130	128	−1.5	1/100			
33				160	20	126	127	0.8	2/100			
34				200	25	120	117	−2.5	2/100			
35				250	45	108	102	−5.6	3/100			
36				330	70	98	79	−19.4	5/100			
37	Composition B		Decreasing continuously	45	45	135	129	−4.4	0/100	1.460	945	97.5
38	Composition C			20	20	130	130	0	0/100	1.431	2020	96.2
39	Composition D			22	22	132	130	−1.5	0/100	1.220	2325	98.3
40	Composition E			40	40	122	123	0.8	0/100	1.475	879	94.9
41	Composition F			20	20	125	122	−2.4	0/100	1.461	922	92.8
42	Composition G			20	20	134	130	−3.0	0/100	1.324	2040	96.7
43	Composition H			20	20	124	122	−1.6	0/100	1.297	2115	97.3
44	Composition I			20	20	133	130	−2.3	0/100	1.259	2190	97.3
45	Composition J			50	20	133	129	−3.0	0/100	1.424	1405	98.1
46	Composition K			50	25	127	128	0.8	0/100	1.451	925	97.6
47	Composition A	Cu+Ni		40	15	200	194	−3.0	0/100	–	–	–
48	Composition A	Cu+Ni+Sn		40	15	212	208	−1.9	0/100	–	–	–

FIGURE 18

	Nd (wt%)	Pr (wt%)	B (wt%)	Al (wt%)	Co (wt%)	Cu (wt%)	Fe
Sintered body composition	24.5	5.5	1.0	0.2	0.5	0.05	bal.

FIGURE 19

Sample No.	Plating conditions	Number of layers	Thickness of hydrogen-rich layer (μ m)			
			1st Layer	2nd Layer	3rd Layer	4th Layer
49	1	2	30	20	—	—
50	2	3	50	30	20	—
51	3	4	40	60	30	20
52	4	1	50	—	—	—
53	5	1	250	—	—	—
54	6	1	350	—	—	—
55	7	0	—	—	—	—

FIGURE 20

Sample No.	Peeling off strength [N/m]			Corrosion resistance	Magnetic properties		
	Before thermal shock test	After thermal shock test	Rate of change [%]		Br [T]	HcJ [kA/m]	Hk/Hcj [%]
49	115	110	-4.3	0/100	1.473	907	96
50	113	107	-5.3	0/100			
51	121	118	-2.5	0/100			
52	120	119	-0.8	0/100			
53	103	104	1.0	3/100			
54	97	93	-4.1	0/100			
55	83	80	-3.6	7/100			